1874MNRAS..34..111C

November 6.—Several outlying portions of white surface of a smaller degree of brilliancy in contiguity, if not physically connected, with *Linné*. The boundary especially uncertain from this cause at the western end and also along the northern side. The southern side is less interrupted, and here the bright surface forming *Linné* terminates more abruptly. There are other spots on the Moon which possess a similar want of distinctness.

November 11 (One day short of full Moon).—Under this illumination the small crater, at least its rim, is much brighter than the flat crater on which it occurs. The peculiarity of its appearance at this time consists in the rapid diminution of brightness from the centre outwards.

December 4.—An offshoot of bright surface from the bright spot towards the S.W. was very distinct.

1868, March 30.—Nearly as sharply defined as neighbouring craters, not the usual cloudy appearance. Ring wall high, especially on the western side. Curious effect of eye retaining a defined object. The small crater appears, by motion of air, to swing to and fro over the white patch.

1873, July 4, $8^h$ to $9^h$ $30^m$.—*Linné* quite nebulous at edges, no regular outline, but broken up by small projections. The oval appeared in the direction of E.S.E. to W.N.W.

August 1.—The direction of the longer axis seems to change while I am looking, sometimes E.S.E. to W.N.W., at others from S.W. to N.E. (the true direction of the shallow crater); the former direction (at right angles to the true one) appears more persistent.

December 27, $6^h$ $30^m$ to $7^h$.—At first oval crater very distinct. Half an hour later I lost the outline of this in a bright nebulous patch. This nebulous light more marked on the longer sides of the oval, so that, as on former occasions, the oval form of the patch seemed sometimes in one direction and sometimes in the opposite direction. The small crater seemed to vary in position on the white patch, as in former years, probably from the varying visibility (from atmospheric changes) of the outside portions of the large crater.

---

## *On the Colour and Brightness of Stars as measured with a new Photometer.* By W. H. M. Christie, Esq., M.A., Fellow of Trinity College, Cambridge.

Various plans have been proposed for referring the colours of stars to a standard scale, but most of them depend on the comparison of the star's light with painted surfaces, which, being necessarily viewed by artificial light, are liable to play the observer false tricks, especially where any colour containing green is concerned. Besides this, the eye is so readily biassed by any coloured light previously seen, that no reliable results are to be expected, unless the star and the comparison light are placed side by side. This is effected in Zöllner's photometer; but the comparison of an artificial star with the interference image of a star as seen in a telescope can hardly be considered satisfactory, at any rate in determining colour, and the use of the tints of polarization is open to the twofold objection, that it must be difficult to match any given *hue*, and nearly impracticable to express the result in terms of the

1874MNRAS..34..111C

three primary colours. As every hue in nature is compounded of white and some colour of the spectrum, or which is the same thing, of the three primary colours, any given hue must be a function of two quantities, and therefore cannot be expressed in terms of a single circle reading, as Zöllner appears to have attempted. In fact, we may express both the intensity and hue of any object by the quantities of red, green, and blue in it, or, if we prefer it, by the quantity of white, together with the quantity and position of some colour in the spectrum.

The instrument which I am about to describe is on the principle of Clerk-Maxwell's Colour-box (described in the *Philosophical Transactions,* 1860), in which definite quantities of red, green, and blue light can be compounded so as to match any given hue.

The objects which I have sought to attain are:

1. To place two uniform surfaces of sensible area side by side and in contact for comparison.
2. To determine both the intensity and hue of the light coming from a star or other body.
3. To obtain a fixed standard of whiteness.
4. To compare the colours of different portions of the disks of the Moon and planets.

It being premised that the photometer is attached to the eye-end of an equatoreal by means of a ring clamp, the general arrangement is as follows:—

The beam of parallel rays, of which the light of a star consists, after passing through the object-glass and eye-piece of the equatoreal, falls on a lens L, at the principal focus of which the eye is placed, so that a round spot of light is seen on one half of the lens, whilst the other half receives the compound comparison light, which will, if a suitable diaphragm be placed in front of the lens, be seen as a round spot in contact with that formed by the star, and exactly of the same size. The diameter of the spot is of course the ratio of the aperture to the magnifying power. The compound light falls on L after having passed through the collimating lens C and prisms P, from three slits, R, G, B, opposite which are the three flames of a paraffin lamp M, of peculiar construction.* The slits R, G, B are so adjusted, that of the light coming from R, and forming a spectrum at the eye-end, the slit E (behind which the eye is placed) will receive red

---

* This arrangement, in fact, constitutes a spectroscope in which three spectra are superposed at the eye-end, but it must be remembered that no eye-piece is used, and that a coloured field, not a spectrum, is seen by the eye at E. The dispersion is given by two flint prisms of 60° (forming a spectrum 4·5 inches in length from A to H at the lamp-end), but for convenience the spectrum is turned through 90° by the use of a right-angled reflecting prism. In any photometric enquiry, simple prisms are much to be preferred to any form of direct vision prism, as with the former suitable stops can be placed to cut off false spectra. The focal lengths of the lenses C and L are 14 and 6 inches respectively.

1874MNRAS..34..111C

rays of a certain refrangibility, whilst it will receive green rays from G, and blue rays from B; the resultant light will therefore be a compound of red, green, and blue, the quantities of each being measured by the products of the width of the slit E into the areas of the slits R, G, and B, respectively.

The first thing, then, is to have the means of varying these areas without removing the eye from E. Without entering into detail, it may be sufficient to explain that the slits slide on a dovetail, and are closed by spiral springs, whilst they are opened by the rods D, E, F, which terminate in a screw and a taper conical head. As the rod is turned, the cone is driven between the jaws of the slit, which thus opens equally on both sides, so that the colour of the light remains unaltered. A horizontal slit, which can, before the observation, be adjusted to any convenient width (not necessarily the same for the three colours) is placed in front of all; the width of the eye-slit is not usually altered unless for stars widely differing in brightness. Having carefully matched the light of any given star by turning the milled heads D, E, F, we have next to measure the areas of the slits R, G, B as accurately as possible. A convenient way of doing this is, after removing the lamp, to place an ordinary scale dynamometer in the channels H, I, K successively, these being so adjusted that the light from a gas jet reflected up the collimator by a tin reflector placed outside C will enter the dynamometer after passing through the slit; both the width and height of the slit can thus be read off by estimation to $\frac{1}{3000}$ inch, the product of the numbers giving the area required. I have also used a graduated steel wedge, but prefer the dynamometer, as not likely to disturb the slits in any way.

The lamp M, on which everything depends, has three ordinary paraffin burners soldered side by side, so as to be opposite the three slits; the chimney is rectangular and of tin, with two narrow horizontal openings covered with glass, one in front to illumine the slits, the other behind to verify the height of the flames at any time.* Owing to the strong draught necessary in a paraffin lamp, it occurred to me that the lamp might be considerably inclined without affecting its burning, and such I have found to be the case; the flame goes straight up the chimney, and remains free from smoke even when the lamp is inclined 60° or 70°, so that by fixing it at an angle of 25° or 30° to the plane of the slits we can work up to the zenith. That objectionable article, a swinging lamp, is thus got rid of; and though there may be a little difficulty in managing three flames, they are, I am convinced, less troublesome than any arrangement for reflecting the light from a single flame down the collimator. The performance of the lamp is very satisfactory, and its light remarkably constant and pure.

---

* This can also be done conveniently by viewing the light from each slit in succession through an eye-piece at E, where it will be easy to see when the white part of the flame falls on the slit.

1874MNRAS..34..111C

I will now pass to the third point, a fixed standard; and it will be necessary to discuss this question at some length, though I do not propose in the present paper to enter on the subject of colour in general, but only in its bearing on the constitution of the heavenly bodies. My first object being to measure the light of stars, I have adopted provisionally the positions of the three standard colours which Clerk-Maxwell gives in the *Philosophical Transactions*, 1860, viz.: Red, wave length (in Fraunhofer's measure) 2328; Green, wave length 1914; and Blue, wave length 1717. Now it appears from Clerk-Maxwell's observations that any colour of the spectrum can be matched by a mixture of any two of these three, but that to match white light we require a mixture of all three, in certain definite proportions. It becomes then a matter of some interest to settle what these proportions are. White light may be taken as that which contains an equal admixture of all the rays of the spectrum, or in other words, which has the same energy for equal areas in all parts of the diffraction spectrum, but in the present state of our knowledge of the relative intensities of the colour sensations this definition has no practical value, and we must be content with assuming some convenient standard, all that is necessary being that it should agree tolerably well with the ordinary notions of white light, and should be universally accessible and not liable to change.

There must evidently be something arbitrary in this selection; but provided our measures are all reduced on one system, it will be easy afterwards to refer them to the absolute standard, should it afterwards be found practicable to determine it.

The only method of eliminating all instrumental influences (such as absorption in the object-glass and eye-piece), is clearly to choose some heavenly body which will be affected in the same degree by these sources of error. The Moon would be the most natural standard, but here we are met by the objection of possible change and the variety of tint introduces a practical difficulty, though by selecting such an object as *Aristarchus* we may get at any rate a provisional standard to be afterwards compared with the ultimate standard. For the latter I would suggest the planet *Venus*, though I have not obtained any measures yet, owing to the present unfavourable position of this planet.

The average of a number of stars would answer the same purpose, and might further serve as the base of a scale of magnitudes, with this advantage over Sir J. Herschel's proposal of *α Centauri* (which, by the way, is not universally accessible), that it is in the highest degree improbable that the average of a number of stars in all parts of the heavens should change appreciably. Considering that observers were more likely to agree in their estimate of 6th magnitude stars, I have selected a number of such stars in which Piazzi, Argelander and Heis agree, thereby giving a great security against change: these should be used as clock stars are in determination of right ascensions, several of

1874MNRAS..34..111C

them being observed in connection with other objects. Taking the mean of these as a standard for 6-magnitude, and Pogson's value of the Light ratio R=2·512, we should have a consistent scale, agreeing well on the whole with Sir W. Herschel's determination of the first six magnitudes, and also with the scale adopted by modern observers. The following table expresses the light of a star of any magnitude in terms of that of a 6-magnitude star:—

| Magnitude | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Light ratio | 100·000 | 39·810 | 15·850 | 6·310 | 2·512 | 1·000 | 0·398 | 0·159 |

Since 5 Log R=2 the values for the lower magnitudes are given by shifting the decimal point two places in the value for the magnitude which is 5 higher in the scale.

But to express the light of a star, as measured with the photometer, in this scale of magnitudes it is necessary to have more observations of the relative intensities of the red, green, and blue, than I have yet been able to obtain. From a mean of 7 comparisons of these in succession with a constant white light (paraffin) it appears that in my instrument 5·9 parts of Red are equivalent in brightness to 14·6 parts of Green, or to 100 parts of Blue. These are expressed in terms of the breadth of the slits in the dispersion spectrum, where the red rays are crowded together and the blue spread out so that the unit is different for rays of different refrangibility; in order to refer them to the diffraction spectrum we must lay down the curve of which the abscissæ are scale readings of the spectroscope and the ordinates wave lengths, the tangent of the inclination of the tangent at any point of this curve will then be the factor for converting the breadth of the slit at that point. For the three standard colours, the factors are 1·84, 0·86, and 0·48, in my instrument. The intensities of the Red, Green, and Blue, in the diffraction spectrum would thus be roughly as 1 : 1 : 4.

It remains to explain how the positions of the principal Fraunhofer lines are determined. An eye-piece being applied at the eye-end, and the eye-slit (which is on a slide) placed in a definite position near the line of collimation, one of the slits at the lamp-end is moved till the line to be measured is brought into the centre of the slit; the scale at the lamp-end (which is divided to $\frac{1}{50}$ in.) is then read off. In practice, it has been found convenient to set the three slits to definite positions, and to move the eye-slit till the sodium lines in the light of the red slit appear, and then, by means of a scale at the eye-end, to set the eye-slit to its proper position.

It might seem that by comparing two similar surfaces, personality would be entirely eliminated, but this is not the case if there be anything like selective absorption in the eye of the observer. In his able paper, previously cited, Clerk-Maxwell points out that there is in most eyes in a greater or less degree

1874MNRAS..34..111C

such an absorption of the rays between the Fraunhofer lines E and F, but confined apparently to the yellow spot of Sœmmering.

With regard to the isolation of a portion of the Moon's or a planet's disk, it may be remarked that, as an image (which may be viewed by an eye-piece) is formed at the eye-slit, the latter may be made use of for this purpose; I have, however, preferred the use of a pinhole at the principal focus of the equatoreal, as enabling the observer to examine a smaller portion of the surface; the diameter of my smallest pinhole is 6″, and it would not be difficult to make one of half that size. For double stars, however, the former method has generally been used.

Though the instrument (which was made for me by Mr. Browning) was received at the end of September 1872, I have not yet been able to accumulate sufficient observations for any certain conclusions, partly owing to the experiments necessary in an inquiry of this kind, but, in a far greater degree, to the very unfavourable weather of the past year. As it is, I have felt constrained to make use of some nights which were hardly suitable for delicate observations. The photometer was attached to the Great Equatoreal of the Royal Observatory, Greenwich, and the subjoined observations were made with it in the last few months; the earlier measures are reserved for future discussion.

| Date. 1873. | Object. | Z.D. ° | No. of Obs. | Areas of Slits. | | | Relative Intensities. | | | Apparent Brightness. | Corrected Brightness. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Red. | Green. | Blue. | Red. | Green. | Blue. | | |
| Aug. 11 | ☽ Aristarchus | 60 | 1 | 676 | 2960 | 5110 | 1150 | 2030 | 511 | 3690 | 4610 |
| Sept. 26 | 95 Herculis B | 55 | 1 | 34·6 | 140 | 470 | 58·8 | 95·9 | 47·0 | 202 | 236 |
| ,, | ,, A | 58 | 1 | 33·1 | 140 | 373 | 56·3 | 95·9 | 37·3 | 190 | 230 |
| ,, | β′ Lyræ | 49 | 1 | 83·2 | 485 | 1010 | 141 | 332 | 101 | 574 | 631 |
| ,, | β Cygni A | 52 | 1 | 132 | 481 | 46·8 | 225 | 329 | 4·7 | 559 | 632 |
| ,, | ,, B | 58 | 1 | 22·9 | 55·8 | 173 | 38·9 | 38·2 | 17·3 | 94·4 | 114 |
| ,, | η Pegasi | 38 | 2 | 126 | 756 | 857 | 214 | 518 | 85·7 | 818 | 851 |
| Sept. 27 | 95 Herculis B | 53 | 2 | 15·9 | 99·2 | 64·3 | 27·0 | 68·0 | 6·4 | 101 | 115 |
| ,, | ,, A | 55 | 2 | 15·9 | 118 | 211 | 27·0 | 80·8 | 21·1 | 129 | 151 |
| ,, | β′ Lyræ | 47 | 4 | 59·0 | 445 | 660 | 100 | 305 | 66·0 | 471 | 508 |
| ,, | γ Lyræ | 52 | 2 | 64·3 | 551 | 834 | 109 | 377 | 83·4 | 569 | 643 |
| ,, | $\chi^1$ Cygni | 57 | 2 | 14·7 | 105 | 117 | 25·0 | 71·9 | 11·7 | 109 | 130 |
| ,, | $\chi^2$ Cygni | 64 | 2 | 23·2 | 87·5 | 9·4 | 39·4 | 59·9 | 0·9 | 100 | 135 |
| Oct. 8 | β′ Lyræ | 46 | 2 | 42·8 | 256 | 484 | 72·8 | 175 | 48·4 | 296 | 317 |
| ,, | γ Lyræ | 45 | 2 | 59·9 | 410 | 739 | 102 | 281 | 73·9 | 457 | 489 |
| Oct. 16 | β′ Lyræ | 48 | 2 | 75·6 | 704 | 828 | 129 | 482 | 82·8 | 694 | 763 |
| ,, | γ Lyræ | 55 | 1 | 82·0 | 767 | 899 | 139 | 525 | 89·9 | 754 | 882 |
| ,, | η Pegasi | 42 | 2 | 137 | 657 | 322 | 233 | 450 | 32·2 | 715 | 751 |
| Oct. 29 | β′ Lyræ | 44 | 2 | 94·0 | 481 | 325 | 160 | 330 | 32·5 | 523 | 554 |
| ,, | γ Lyræ | 47 | 3 | 89·0 | 557 | 495 | 151 | 382 | 49·5 | 583 | 629 |

1874MNRAS..34..111C

| Date 1873. | | Object. | Z.D. ° | No. of Obs. | Areas of Slits. Red. | Green. | Blue. | Relative Intensities. Red. | Green. | Blue. | Apparent Brightness. | Corrected Brightness. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nov. | 1 | Schjell. 241 | 55 | 2 | 9·1 | 46·2 | 133 | 15.5 | 31·6 | 13·3 | 60·4 | 70·7 |
| ,, | | β′ Lyræ | 61 | 3 | 60·0 | 661 | 655 | 102 | 453 | 65·5 | 621 | 789 |
| Nov. | 3 | β′ Lyræ | 53 | 3 | 69·4 | 491 | 441 | 118 | 336 | 44·1 | 498 | 568 |
| ,, | | γ Lyræ | 58 | 2 | 91·1 | 656 | 762 | 155 | 449 | 76·2 | 680 | 823 |
| ,, | | Schjell. 241 | 69 | 2 | 13·8 | 43·8 | 0·6 | 23·5 | 30·0 | 0·1 | 53·6 | 80·9 |
| ,, | | 41 Pegasi * | 49 | 1 | 9·0 | 43·5 | 56·4 | 15·3 | 29·8 | 5·6 | 50·7 | 55·8 |
| ,, | | 40 Pegasi * | 51 | 1 | 15·3 | 66·1 | 2·4 | 26·0 | 45·3 | 0·2 | 71·5 | 80·1 |
| ,, | | 45 Pegasi * | 52 | 1 | 14·4 | 60·3 | 0·0 | 24·5 | 41·3 | 0·0 | 65·8 | 74·4 |
| ,, | | 52 Pegasi * | 58 | 1 | 9·5 | 63·8 | 0·0 | 16·1 | 43·7 | 0·0 | 59·8 | 72·4 |
| ,, | | η Pegasi | 53 | 2 | 238 | 1500 | 1470 | 405 | 1030 | 147 | 1580 | 1800 |
| ,, | | β Pegasi | 54 | 1 | 290 | 1910 | 808 | 493 | 1310 | 80·8 | 1880 | 2160 |
| ,, | | ☽ Mare Imbrium | 45 | 1 | 205 | 1770 | 3470 | 349 | 1210 | 347 | 1910 | 2040 |
| Nov. | 12 | Schjell. 241 | 64 | 3 | 8·1 | 32·4 | 0·0 | 13·8 | 22·2 | 0·0 | 36·0 | 48·6 |
| ,, | | 40 Pegasi * | 44 | 1 | 10·4 | 51·8 | 0·0 | 17·7 | 35·5 | 0·0 | 53·2 | 56·4 |
| ,, | | 41 Pegasi * | 46 | 1 | 5·7 | 33·8 | 78·4 | 9·7 | 23·2 | 7·8 | 40·7 | 43·5 |
| ,, | | η Pegasi | 44 | 2 | 129 | 1150 | 468 | 219 | 788 | 46·8 | 1050 | 1110 |
| ,, | | β Pegasi | 50 | 2 | 278 | 1320 | 26 | 473 | 904 | 2·6 | 1380 | 1530 |
| ,, | | 60 Pegasi * | 59 | 1 | 6·5 | 39·5 | 14·0 | 11·1 | 27·1 | 1·4 | 39.6 | 48·7 |
| ,, | | $n^1$ Orionis * | 52 | 1 | 7·5 | 130 | 98·0 | 12·8 | 89·1 | 9·8 | 112 | 127 |
| ,, | | $n^2$ Orionis * | 51 | 1 | 9·0 | 129 | 14·0 | 15·3 | 88·4 | 1·4 | 105 | 118 |
| Nov. | 30 | η Pegasi | 53 | 1 | 97·5 | 623 | 268 | 166 | 427 | 26·8 | 620 | 707 |
| ,, | | β Pegasi | 60 | 1 | 166 | 847 | 258 | 282 | 580 | 25·8 | 888 | 1110 |
| ,, | | λ Tauri | 42 | 2 | 65·3 | 425 | 466 | 111 | 291 | 46·6 | 449 | 471 |
| ,, | | $n^1$ Orionis * | 50 | 1 | 13·6 | 101 | 112 | 23·1 | 69·2 | 11·2 | 104 | 114 |
| ,, | | $n^2$ Orionis * | 50 | 1 | 12·8 | 101 | 32·7 | 21·8 | 69·2 | 3·3 | 94·3 | 105 |
| Dec. | 31 | η Pegasi | 63 | 3 | 117 | 710 | 293 | 199 | 486 | 29·3 | 714 | 942 |
| ,, | | λ Tauri | 47 | 2 | 94·4 | 497 | 597 | 160 | 340 | 59·7 | 560 | 599 |
| ,, | | $n^1$ Orionis * | 53 | 2 | 9·8 | 80·8 | 146 | 16·7 | 55·3 | 14·6 | 86·6 | 98·7 |

---

* Standard 6th magnitude stars:

Aug. 11. Hazy clouds; brightness of moon variable; many attempts made to get a good match. Diameter of Pinhole, 8″·6.
Sept. 26. East wind; images bad, and brightness variable.
Sept. 27. Definition good at times; south wind.
Oct. 8. Sky hazy, and definition variable. Bright moonlight.
Oct. 29. Rather foggy; images not good. Moonlight.
Nov. 3. Images fairly good. Diameter of Pinhole (for Moon), 8″·6.
Nov. 12. East wind; images bad, generally granulated, with rare fits of fair definition; colours of stars seemed variable.
Nov. 30. Sky hazy, except for $n^1$ and $n^2$ *Orionis*. Moonlight.
Dec. 31. Brightness and colour of stars very variable.

1874MNRAS..34..111C

The numbers given in the columns headed Areas of Slits express the areas of the several slits in square $\frac{1}{500}$ inch, all the measures being referred to the same width of eye-slit ($\frac{1}{50}$ inch), and three significant figures only being retained; the same power (130) was used throughout on the equatoreal, though with very bright stars there is an advantage in using a lower power, whilst for stars below 6 mag. a high power which concentrates their light is perhaps better.

The next three columns are formed by multiplying the three preceding columns by $\frac{10}{5\cdot9} = 1\cdot70$, $\frac{10}{14\cdot6} = \cdot685$, and $\frac{10}{100} = 0\cdot1$, and express the intensities of the three colours in each case; the sum of these numbers is taken in the next column, which gives the apparent brightness subject to a correction for atmospheric absorption. This correction (taken from Seidel's Table) is applied in the last column, which therefore expresses the brightness of a star as it would be seen at the zenith. There is very little doubt that a different correction ought to be applied for each colour, so that the present reduction must be regarded as provisional, but it will serve to illustrate the method which may be advantageously employed. I have not thought it worth while at present to reduce these observations to the scale of magnitudes, which I have proposed. This will be done more advantageously when more observations have been collected, for it is evident that even with the selected 6th magnitude stars, there is no such approach to equality as we have a right to demand. There can be no doubt, for instance, that both $n^1$ and $n^2$ *Orionis* are now nearly twice as bright as an average 6-magnitude star, and yet we find Piazzi, Argelander, and Heis agreeing to one-sixth of a magnitude, and all three calling them 6·0 magnitude.

As might be expected, in observations of such a nature with a new instrument, there are certain anomalies in these measures which are probably due in part to scintillation, the effect of which is to make the star's light change from orange or yellow to blue-purple; this was remarked very distinctly on December 31. Another cause of error which, however, affects the brightness rather than the colour of stars, is the dryness of the air: with an east wind the spot of light usually becomes granulated, and there is in consequence a strong tendency to over-estimate its brightness. From a comparison of the discordance of the separate results for the same star on any one night, the mean error of a single measure appears to be about 10 per cent., equivalent to 0·1 of a magnitude. But after due allowance has been made for all probable sources of error, there remain discordances which seem to imply rapid changes of colour in some of the stars examined. Now change of colour shows a physical change, for it

1874MNRAS..34..111C

is extremely improbable that such a phenomenon should be caused by rotation. We know that as the temperature of a solid is raised, the colour changes from red to white, radiations of all wave lengths increasing, but the blue more than the red; now, we see something similar to this in the results for $\eta$ *Pegasi*, $\beta$ *Pegasi*, and Schjellerup 241; but I do not wish to insist strongly on the few measures I have obtained as yet, though there can be no doubt that $\eta$ *Pegasi* is a new variable star of moderate period. Owing to unfavourable weather, the observations are for the most part separated by such long intervals as to give but little information on the light curves, and from the same cause I have been baffled in my attempts at observing a minimum of $\beta$ *Lyræ* or *Algol*; the observation of $\lambda$ *Tauri* on November 30, at $12^h\ 25^m$ G. M. T., was close to the minimum. If changes in the colours of stars are due to gases, as would seem probable, the law of radiation, given above for solids, will have to be modified; thus, an increase of temperature (in the case of hydrogen) would, I fancy, increase the red and blue without affecting the green. But to get further information on this point, we require measures of the colours of gaseous bodies under various conditions of temperature and pressure. In this way the photometer will supplement the spectroscope, for though it cannot give us the same definite information on the constituent elements of the heavenly bodies, it may tell us something about changes of temperature and pressure, and may be readily applied to the fainter orders of stars, a field left untouched by the spectroscope. Even with the brighter stars, much may be done by the help of a good photometer with which the *absolute* amounts of the three standard colours can be measured, for among the numerous lines of stellar spectra it must be very difficult to trace changes, but a change in colour will at any rate guide the search; thus, if the red and green increase together, a bright line has probably appeared in the intermediate yellow, or a dark line has faded out; again, if the green and blue decrease together, a bright line has probably faded out in the region near F.

A few words, in conclusion, on another application of this instrument. Recent researches have shown the importance of determining the changes in the relative brightness of the lines in the spectra of gases with changes of temperature; now, though I have not tried the experiment, yet I conceive there would be no difficulty in combining the photometer with a spectroscope so as to match the different bright lines, which might be done either by placing the lens L at the principal focus of the spectroscope, or by the use of an eye-piece as in measures of stars.

And now, having pointed out the results which we may hope for from such measures, I would earnestly commend this branch of astronomy to all those who have equatoreals, and do not know exactly what useful work to take up with them. With a very moderate expenditure of time and money they may do valuable work in sidereal photometry with the promise of a rich harvest of discoveries.